Abundance and distribution of coral and coral mortar in the Powder Magazine at Fort Vancouver, WA circa 1832

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Abstract

The foundation of the powder magazine at Fort Vancouver, Washington was constructed in 1832 utilizing mortar made by the heating and crushing of Hawaiian coral. Coral and mortar fragments which withstood the original mortar making process and the subsequent 172 years of weathering were excavated in 2004 and sent to our lab for identification and analysis. The coral fragments were separated from the mortar, identified by genus, and weighed. The results were mostly consistent with a typical live Hawaiian reef with the vast majority of samples being *Porites* (98.5% by weight). *Pocillopora* were not as abundant as expected (0.08% by weight) which may be due to weathering, purposeful harvesting, or its inability to withstand the mortar making process. *Leptastrea* was also present in the samples (1.39% by weight). There was no discernable spatial pattern to the distribution of coral genera in the powder magazine foundation.

Introduction

The powder magazine at Fort Vancouver was constructed in 1832 and functioned as a vital component of the Hudson's Bay Company's operations at the height of the fur trade. The structure held large amounts of gunpowder prior to distribution to other forts,

Native Americans, missionaries, and American settlers. The powder magazine, though located in the Pacific Northwest, was built utilizing methods and materials originating thousands of miles away. Two supply ships per year would arrive at Fort Vancouver with goods from Britain, as well as raw materials such as coral from the Hawaiian Islands. It is this coral that was processed into lime and used as mortar in the Fort's only brick structure (Wilson et al., 2004).

The practice of lime and plaster mortar in Hawaii dates back to 1798, but its usage rose steeply in the 1830s and 1840s. This rise in popularity was largely due to the influence of missionaries who disliked the traditional thatched dwelling of native Hawaiians and wanted to distance themselves from this organic style of living for one they considered more "civilized". As western influence heightened, the use of mortar was employed by chiefs and other elite Hawaiians for much the same reasons (Mills, unpublished data).

The missionaries themselves were familiar with the burning of limestone in kilns in order to produce the lime needed for mortar but were forced to adopt an alternative raw material native to the islands. Coral was consequently substituted for limestone, apparently burned and processed in pits dug into the ground (Mills, unpublished data). Without special kilns which reach extremely high temperatures, the coral is not completely broken down, and fragments are dispersed throughout the mortar during construction. The pieces which remain after this process are the focus of this study.

To form the foundation of the Powder Magazine, coral mortar was mixed with stone rubble and cemented into a 2ft wide trench (Hoffman, 1974). This was likely undertaken by Hawaiian laborers living at the fort during the 1830's. Although there have

been previous excavations of the Powder Magazine in 1947 and 1972, all samples examined in this study came from excavations done by the field school at Fort Vancouver in 2004. The questions of our study are 1) what coral species are present in the mortar samples, 2) what is the relative abundance of these species, and 3) how are the species distributed throughout the structure's foundation.

Materials and Methods

Bins containing coral mortar fragments were supplied by Fort Vancouver archeologists along with GIS data and a corresponding spreadsheet indicating sample location in the magazine (Figs 1,2). Additional columns for cataloguing taxa, numbers, weight, and comments were added to the spreadsheet. Samples were removed from each bag and individual pieces were examined under a Nikon SMZ645 microscope. Samples were then separated into two piles: coral and mortar. If any part of a sample could be identified as coral, the entire sample piece was counted as "coral" (i.e. no attempt was made to separate a coral fragment from the mortar surrounding it). At some point, ground coral becomes mortar, making identification difficult to impossible. For our study, "mortar" was defined as a mixture of rubble and mortar in which the individual calices of the coral skeleton have been degraded beyond recognition.

The sample count was checked against what was marked on the bag, and any discrepancies were noted in the comments section. Coral fragments were identified to genus and then counted and weighed. Mortar pieces were also counted and weighed. Dust was considered insignificant and was separated prior to weighing and placed back into

the original bag. Coral pieces were placed into individual bags based on genus and returned to the original sample bag.

Results

A total of 11,492 samples were counted, identified, and weighed. 7,554 of the samples were determined to be mortar. Of the remaining 3,938 pieces which were identified as coral, the vast majority were *Porites*, followed by *Leptastrea* and *Pocillopora*, respectively (Table 1).

The distribution of coral fragments within the powder magazine was created by incorporating these data with GIS maps supplied by Fort Vancouver archeologists. The distribution of coral fragments throughout the magazine's foundation displayed no discernable pattern for any of the genera by unit (Figs 3,4,5,6) or by level (Table 2). A Chi Square test showed the distribution of coral genera to be significantly different from what is found on a typical live Hawaiian reef ($P = <0.01$, $\alpha = 0.05$, $X^2 = 205.2$, $\nu = 2$).

Discussion

The species abundance of a typical live reef on the Kona coast off the island of Hawaii is 96.4% *Porites*, 2.5% *Pocillopora*, 1.1% *Montipora*, <1.0% *Pavona* and 0.01% Leptastrea (Tissot, 2006). These data are somewhat consistent with our findings from the Powder Magazine mortar with *Porites* at 98.5% by weight and 99.4% by sample size. However, based on the reef data, we would have expected to find more than 0.23% *Pocillopora* or to at least have it appear as the second most abundant genera. One possibility for this lower than expected value is that *Pocillopora* does not hold up well to

the intense heat and crushing action carried out during the lime making process. It is also possible that *Porites* was specifically harvested over other genera due to its larger size, thereby generating maximum raw material per dive.

Although there was no obvious pattern to the distribution of coral genera within the magazine's foundation, there does seem to be a higher concentration of all samples in the excavation units located along its western half. This concentration can likely be attributed to several factors. First, this section of the foundation has been covered by a concrete pad since the 1960's (represented in Fig. 1 and Fig. 2 as dark, square outline). This pad has protected this section from weathering and other disturbances to a greater degree than the rest of the foundation. In addition, this area had not been dug before (other sections of the foundation had previously been uncovered by Louis Caywood in 1947 and excavated in 1972 by National Park Service archaeologists). These factors, plus the fact that parts of the foundation have been left intact for historical purposes, make any further analysis of coral distribution impractical at this time.

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